Nanotechnology: An EPA Perspective

Factsheet

Nanotechnology is one of the top research priorities of the U.S. government. EPA is a part of the government-wide National Nanotechnology Initiative (NNI), which provides coordination and direction for this emerging field. While many definitions for nanotechnology exist, the NNI calls it "nanotechnology" only if it involves all of the following:

1. Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 - 100 nanometers,
2. Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate sizes, and
3. Ability to be controlled or manipulated on the atomic scale.

www.nano.gov

How does nanotechnology relate to the environment?

The laws of quantum mechanics often cause dramatic changes in the mechanical, optical, chemical, and electronic properties of materials on the nanoscale. These properties lead to useful and enhanced applications of nanotechnology in environmental protection including sensors for improved monitoring and detection capabilities, treatment and remediation techniques for cost-effective and specific site cleanup, green manufacturing to eliminate the generation of waste products, and green energy technology for the creation of commercially viable clean energy sources.

Manufactured nanomaterials might also pose risks to human health and other organisms due to their composition, reactivity, and unique size. Thus it is equally important to consider potential interactions of nanomaterials with the environment and the associated risks. This involves studying the effects of natural nanoparticles in the air and soil, lifecycle aspects of manufactured nanomaterials, and their fate and transport. Risk assessment also includes studies on the toxicity of natural and manufactured nanomaterials, as well as their routes of exposure to humans and other organisms and potential for bioaccumulation.

What is EPA doing in nanotechnology?

EPA has taken a leadership role in planning research directions for the environmental applications and implications of nanotechnology—through its own research programs and participation in the interagency Nanoscale Science, Engineering, and Technology subcommittee of the White House Office of Science and Technology Policy, National Science and Technology Council.

EPA's nanotechnology efforts conducted by the Office of Research and Development (ORD) include the following:

ORD's National Center for Environmental Research through the Science to Achieve Results program, EPA has funded 32 research grants for more than $11 million in the applications of nanotechnology to protect the environment including the following: development of low-cost, rapid, and simplified methods of removing toxic contaminants from surface water; new sensors that are more

sensitive for measuring pollutants; green manufacturing of nanomaterials; and more efficient, selective catalysts. At least one project is moving rapidly toward commercial application—zero-valent iron nanoparticles have been modified so that they can be used to reduce chlorinated organics in contaminated ground-water sites. **www.epa.gov/ncer**

Twelve recently selected research projects focus on studying the possible harmful effects of manufactured nanomaterials, i.e., toxicity, fate, transport and transformation, and exposure and bioaccumulation. A new research solicitation for 2005 was announced in collaboration with two other federal agencies to study the health and environmental effects of manufactured nanomaterials.

Through its Small Business Innovation Research Program, EPA awarded contracts to over 20 small companies to develop and commercialize nanomaterials and clean technologies. Recently, an SBIR company demonstrated an activated carbon nanofiber filter with large surface area that more efficiently removes volatile organic compounds and particles smaller than 3μm from engine exhaust, power generators, and indoor air.

A number of research projects in ORD laboratories are being conducted including such topics as the following: nanostructured photocatalysts as green alternatives to oxygenation of hydrocarbons; using nanomaterials as adsorbents, membranes and catalysts to control air pollution and emissions; and the effects of ultrafine particulate matter that could help inform the research on manufactured nanomaterials.

Research Workshops and Symposia

The NNI's "grand challenges," as stated by the National Nanotechnology Initiative, focus on the applications of nanotechnology that have the potential for significant economic, governmental, and societal impact. EPA scientists and engineers organized a workshop to determine research directions under the "grand challenge" on nanotechnology and the environment. The report can be found at: **http://es.epa.gov/ncer/publications/nano/nanotechnology4-20-04.pdf**

In 2003 and 2004, EPA scientists and engineers—along with their university, government and industrial colleagues—organized a 5-day symposium on nanotechnology and the environment at the American Chemical Society's annual meeting. Another symposium will be held in 2005. A book of proceedings from the 2003 meeting is due for release at the end of 2004.

Researchers from seven federal agencies presented results on nanotechnology applications and implications for the environment at a workshop held in 2003. Proceedings can be found at: **http://es.epa.gov/ncer/publications/nano/index.html**

Two EPA STAR research progress reviews have been held to summarize research results. Proceedings can be found at **http://es.epa.gov/ncer/publications/workshop/nano_proceed.pdf**

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